Development of Low Cost MEA3 Process

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DuPont Fuel Cells

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Overview

DOE Hydrogen Program

Timeline

- March 1, 2006
- December 31, 2007
- 100% Complete

Budget

- Total project funding
  - DOE share $345,000.00
  - Contractor share $345,000.00
  - Funding received in FY07 $124,054.00
- Funding for FY08 $0

Barriers

- Barriers addressed
  - A. Lack of high-volume membrane electrode assembly (MEA) processes
  - F. Low levels of quality control and inflexible processes

Partners

- SFC Smart Fuel Cells
- Project lead – DuPont Fuel Cells

Objectives

Develop low cost MEA3 process

"A feasibility assessment of high throughput screen printing processes considering top level "for" and "against" aspects, so that poor alternatives can be eliminated and better ideas are prioritized for further work"

Develop Product by Process Transfer functions

relationships between MEA manufacturing control points and performance of MEA`s in DMFC Stacks.

Milestones for FY07

- Complete process assessment (July 2007)
- Complete verification of transfer function (October 2007)

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Approach

The Five-Phase DMADV Methodology

- **Define** Determine objectives and deployment.
- **Measure** Understand customer needs and specify measurable design requirements (CTQs).
- **Analyze** Develop concept design.
- **Design** Develop details and optimized design.
- **Verify** Verify performance.

** DMADV ... Six Sigma Methodology*

- Six Sigma Methodology
- Systematic development path
- Thorough analysis of the challenges and related solution steps

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Background

Challenges for DMFC Technology Implimentation:

- High cost
- Low performance
- Lack of market demand
- Lack of investment

Possible Solution:

- Low cost, high performing DMFC system
- Simplification of the manufacturing process
- High throughput manufacturing process

- Project Y =
  - Low Cost Process (low and high volume scenarios)

- Key X =
  - Yield
  - Productivity
  - Quality
  - Capacity
  - Overall MEA Process & Line balance

Transfer Functions

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INPUT PARAMETERS

- **Coating Process**
  - Printing Conditions
  - Catalyst Loading
  - Substrate
- **Laminating Process**
  - Temperature
  - Pressure
  - Line Speed
  - Membrane Conditions
- **Cell Hardware**
  - DFC 25 cm^2 Hardware
  - SFC Single Cell
  - SFC Stack

OUTPUT PARAMETERS

- CELL PERFORMANCE
- STACK PERFORMANCE
- STACK OPERATING LIFE

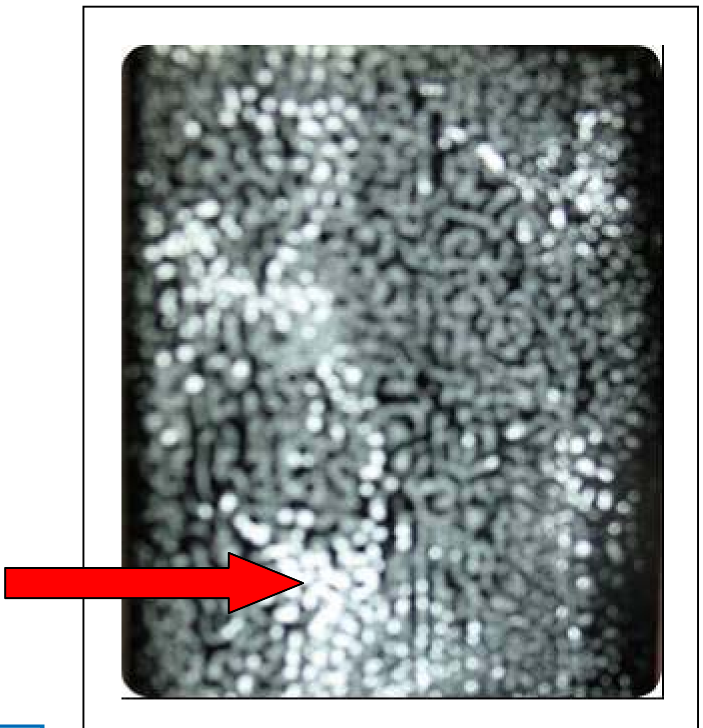
Rotary Coater Capability

- Up to 500 cm^2 active area using the rotary screen module
- Use quantities of catalyst ink in the range of 4000 gram batches
- Long print runs to meet yield targets
- Printing may be done on either side of a substrate and in multiple passes if necessary.
- Registration of printed images from side-to-side can be within 0.5 mm (20 mils) of each other
- High capacity upto 20,000 m^2/yr

Process Development

Catalyst Coating

- **New ink formulation (solid content, binder content, solvent type)**
- **Ink properties adjustment - compatibility to coating process**
- **Substrate surface properties**
- **Screen type and dimensions (mesh, emulsion, snap height etc.)**

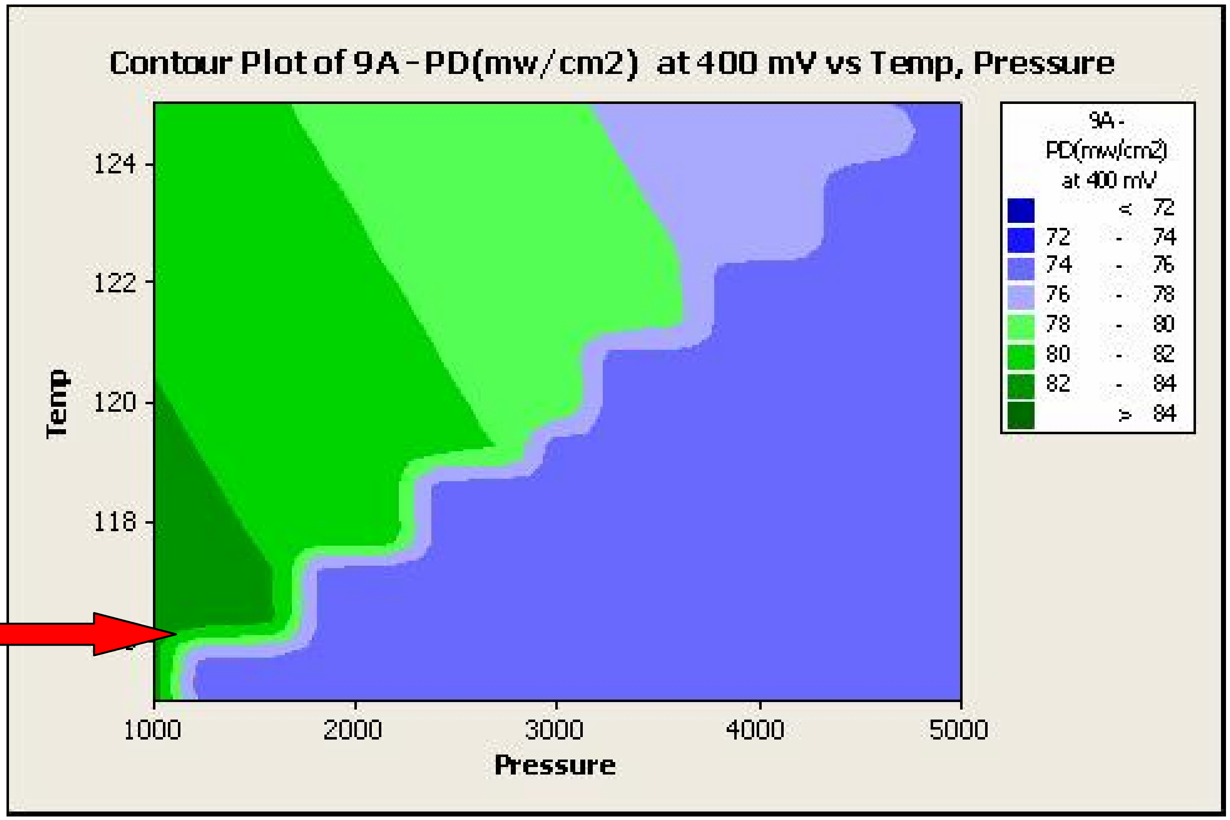


Coarse Screen

Fine Screen

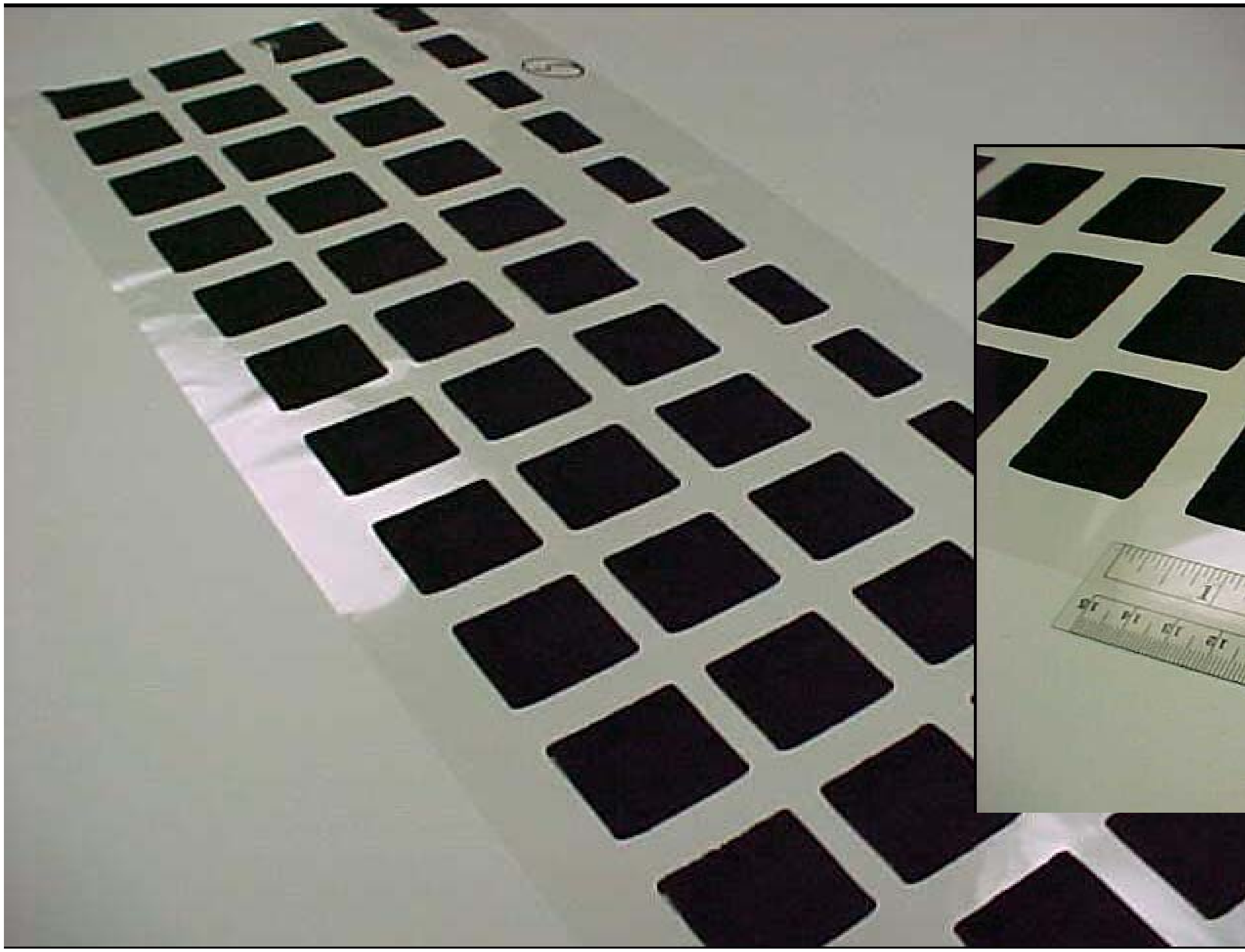
Process Development
Lamination

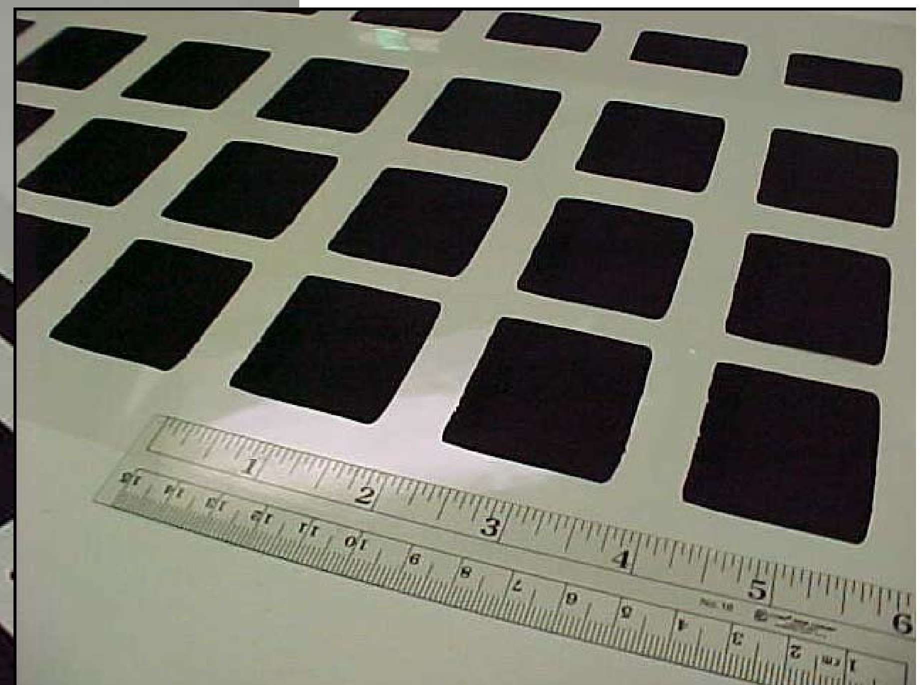
- **Lamination conditions (Pressure, Temperature, Line speed)**
- **Type of equipment (Heating, cooling, Pressure variability)**
- **Lamination quality *vs.* Membrane properties (Moisture, thickness)**



Rotary Screen Printing

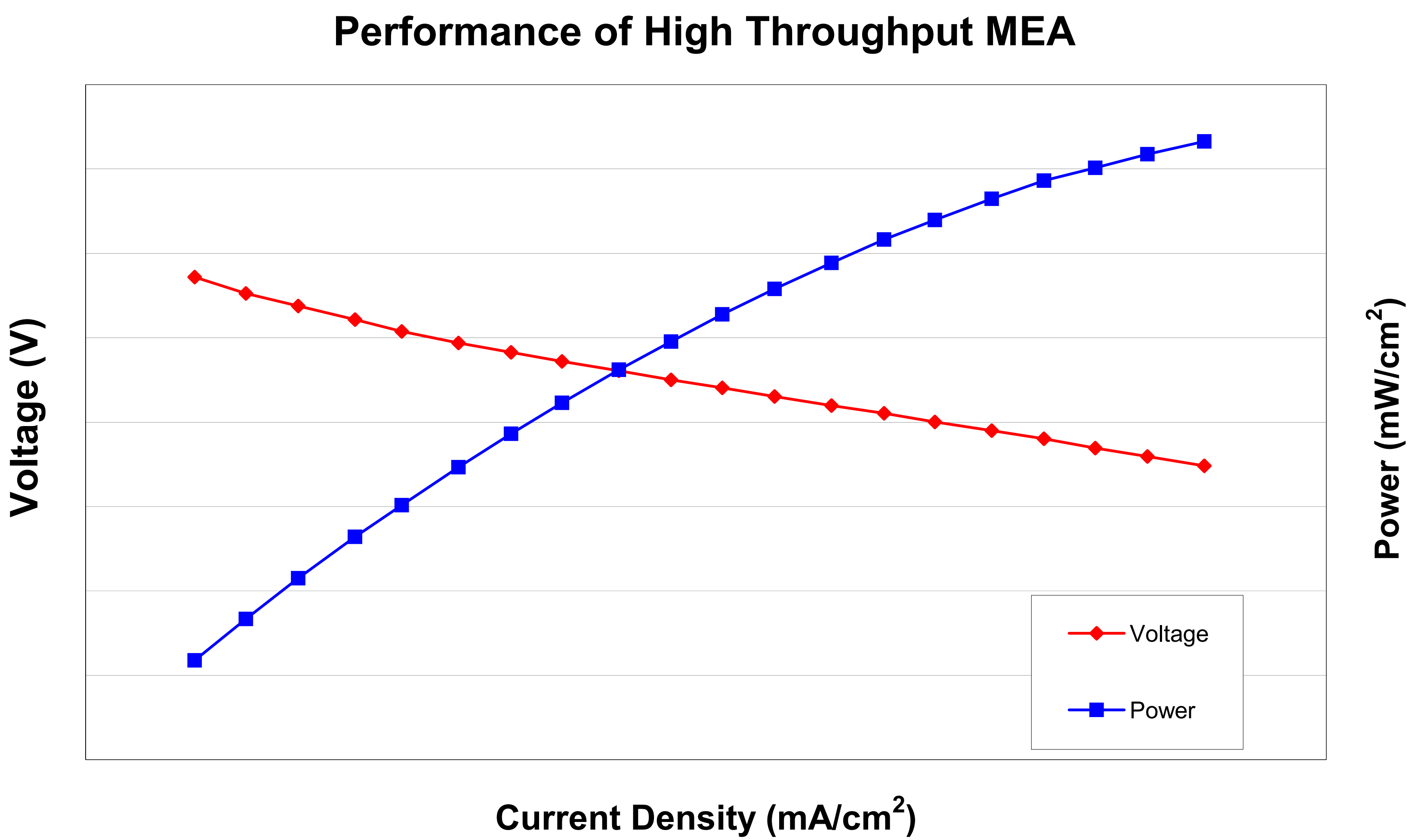
Successful demonstration of roll-to-roll process





Performance

Single Cell in DFC Hardware



Performance Improvement

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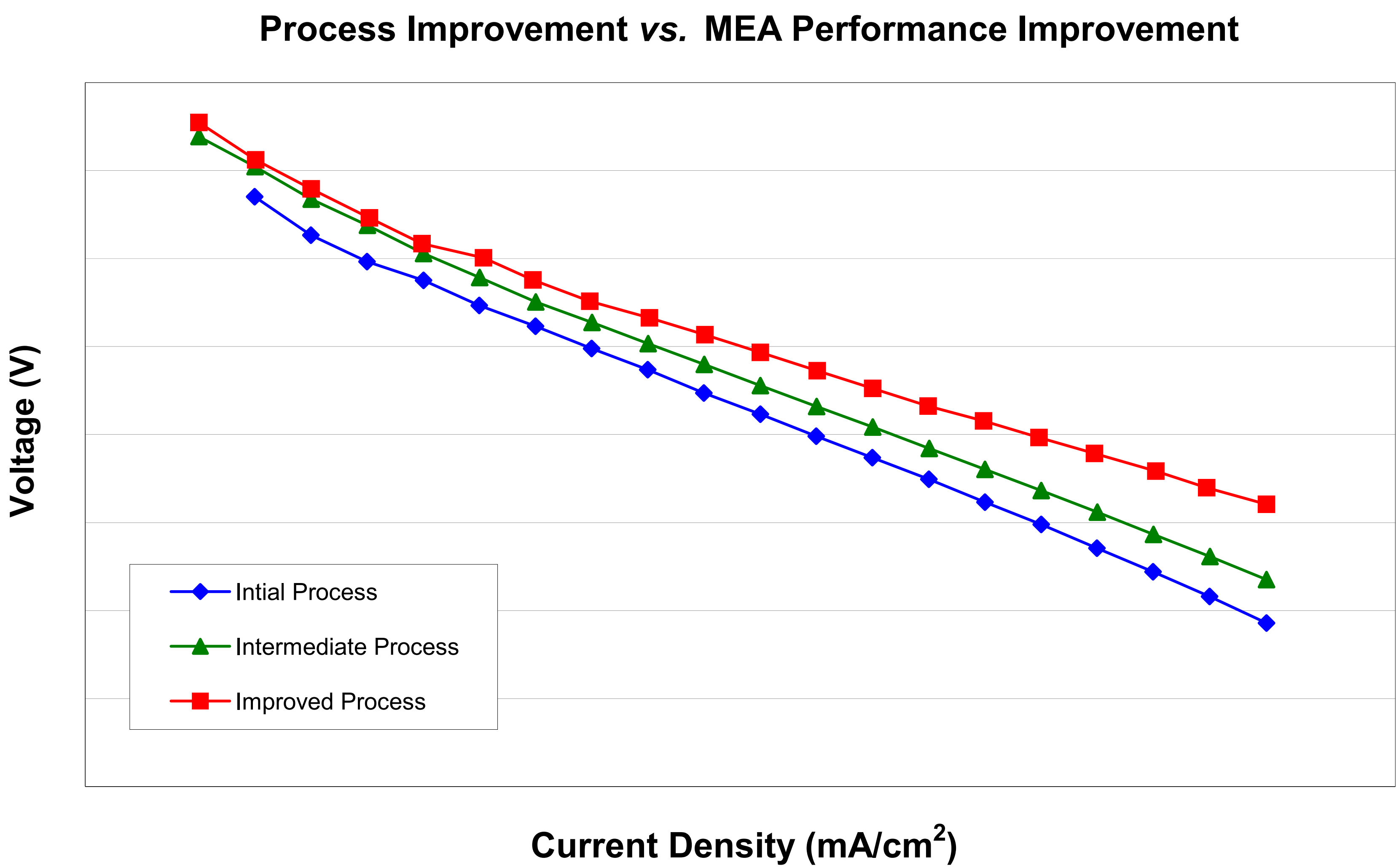

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Performance Improvement

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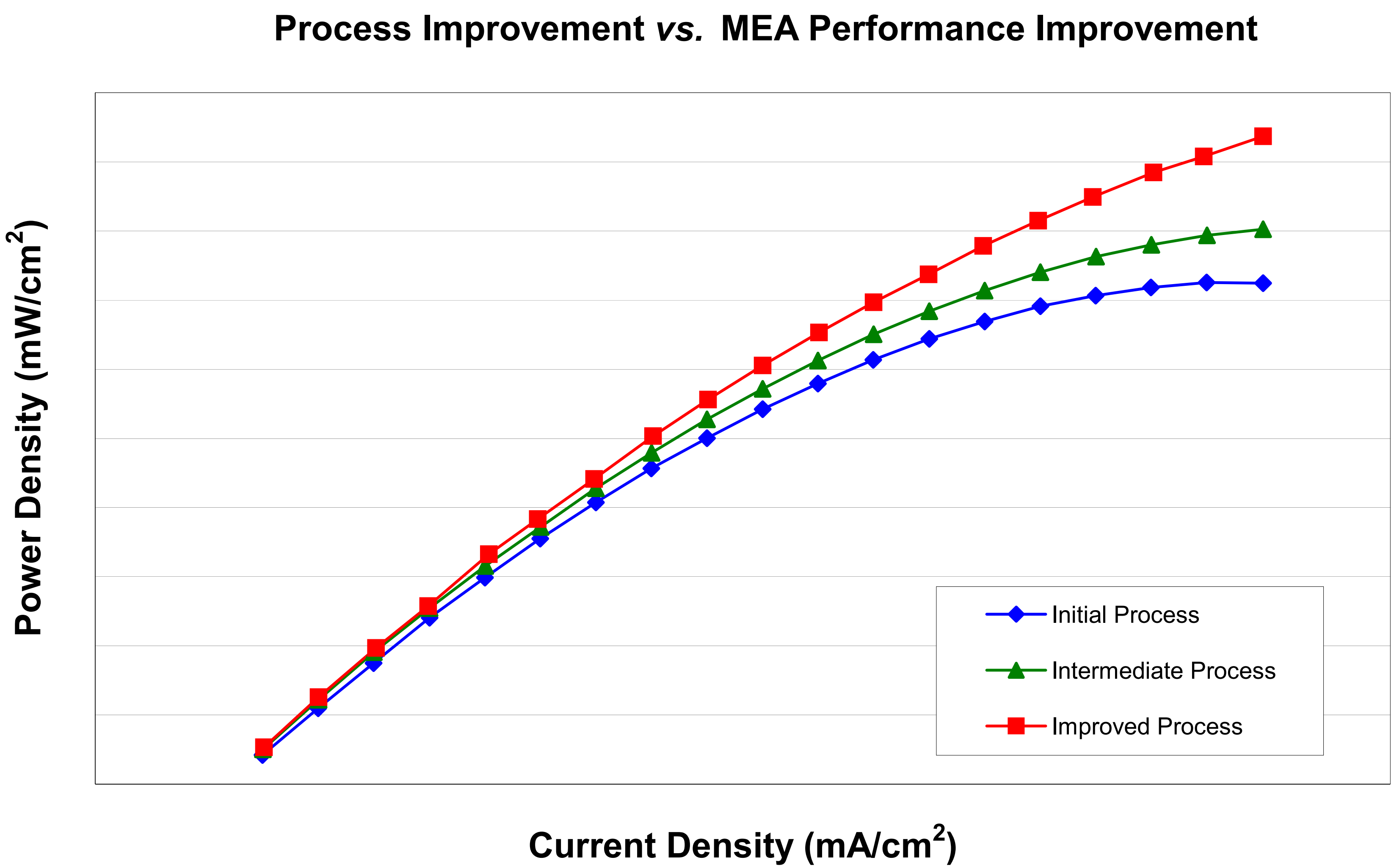

Stack Performance

- A 21 Cell SFC Stack was assembled using MEA's from improved process.
- The BOL performance of the stack was 500 mV under SFC's operational condition.
- The performance of the stack was 380 mV, when it was stopped after 2500 hrs of operation.
- The overall decay rate of the stack was 48 μV/hr, which is very good.
- Overall the stack performed satisfactorily.

Transfer Function Summary Slide

- All MEA3's were first evaluated on 25 cm^2 DFC cell hardware.
- To establish their performance correlation and to understand the effect of active area increase, improved MEA3's were evaluated in both 25 cm^2 DFC cell hardware and 50 cm^2 SFC cell hardware.
- The correlation parameters were used for process improvement and then to fabricate improved MEA3 for stack evaluation.

Summary

- Completed study of low-cost MEA3 process to understand the effect of manufacturing parameters on the performance of the MEA3.
- Feasibility of a static screen versus a roll printing process was studied for manufacturing DMFC MEA3.
- Preliminary assessment of transfer function and MEA3 performance was explored.